Inflation and reputation

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RESEARCH MEMORANDUM

INFLATION AND REPUTATION: COMMENT

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FEW 267

INFLATION AND REPUTATION: COMMENT

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In a recent article in this Review (June 1985) David Backus and John Driffill develop a model which can explain when and why governments inflate in a rational expectations environment. In this introduction the history of the problem will be sketched with game theory terminology and the approach chosen by Backus and Driffill will be summarized. The following sections will attend to necessary corrections and the consequences of these corrections.

The problem goes back to an example in a paper by Finn Kydland and Edward Prescott (1977, p. 477). They compare what they call the consistent equilibrium with some inflation to the optimal equilibrium with no inflation. The optimal equilibrium is better than the consistent equilibrium because in both cases unemployment ends up at its natural rate. In game theory terms they compare the Nash outcome to the Stackelberg outcome where the Stackelberg outcome is Pareto superior. In this game the government chooses actual inflation and the private sector chooses expected inflation. Although it is assumed that government and private sector make their

*) I am indebted to Jan Potters for expressing his unease with the article commented upon which eventually led to this comment and to Thijs ten Raa for helpful suggestions regarding the text.

choices simultaneously, the government might acquire leadership by announcing the choice beforehand. If the private sector believes the announcement, the Stackelberg (optimal) outcome with no inflation results. However, a problem of credibility arises. The point is that the government can consider to announce zero inflation and to inflate nevertheless in order to create surprise inflation which raises output and lowers unemployment. Therefore it is said that the announcement of zero inflation is not credible. In fact the only credible announcement in this respect is the Nash announcement. However, low inflation can become credible when time and future are introduced or, to put it differently, when the game is repeated. The idea is that the government will not cheat on announced inflation when it will be punished with high inflation and unemployment in the future. Robert Barro and David Gordon (1983) find what they call the best enforceable rule in a repeated game with infinite horizon and a punishment interval of one period. This credible rule lies somewhere inbetween the Nash and Stackelberg announcements and can be characterized as low but nonzero inflation.

The problem with a finite horizon suffers from the "chain-store paradox" introduced by Reinhard Selten (1978). In the final period the rational government will always inflate: there is no demonstration effect of not cheating, because there is no future to gain from this effect. A backward recursive argument leads to inflation in all periods. David Kreps and Robert Wilson (1982) develop a concept of reputation in this type of models by introducing imperfect information. Backus and Driffill apply this idea to the problem at stake. The private sector is not sure that it is dealing with a "wet" government which is struggling with the trade off between inflation and unemployment. The government might be of the "hard-nosed" type that fights inflation at all costs. In turn the "wet" government can use this uncertainty on the side of the private sector to build up a reputation of being "hard-nosed" in order to have the private sector believing announcements of zero inflation. The equilibrium concept that is used is called sequential equilibrium. The game is solved in a dynamic programming framework which yields subgame perfectness and thus time consistency. At every stage a mixed strategy Nash equilibrium is calculated given the probability attached by the private sector to the government being "hard-nosed" (the reputation). The series of these probabilities satisfies Bayes' rule.

The purpose of this comment is to show that the reputational equilibrium derived by Backus and Driffill is not a sequential equilibrium (the same applies to the result of Kreps and Wilson). A small adjustment leads to a sequential equilibrium, but this reputational equilibrium does not yield one of the main conclusions of the Backus and Driffill analysis. Their conclusion that if the initial reputation is bad the model generates recessions with a positive probability does not hold. Section I corrects Sections II and III from the article by Backus and Driffill. Section II is a conclusion.

I. Reputational Equilibrium

On page 534 Backus and Driffill write "The government now chooses y_{T-1} to maximize (5) subject to (3)". In (5) the value $v_g(T,p_T)$ of the game for the government at the final period occurs. The expression for $v_g(T,p_T)$ can be found on page 533. Because at this point for $p_T = \frac{1}{2}$ the public is indifferent about its action z_T, the precise expression for $v_g(T,p_T)$ is

$$v_g(T,p_T) = \begin{cases} 1 & , p_T > \frac{1}{2}, \\ 2z_T - 1, & p_T = \frac{1}{2}, \\ -1 & , p_T < \frac{1}{2}. \end{cases}$$

The crucial point is that, in contrast with what Backus and Driffill claim, for all $p_{T-1} \leqq \frac{1}{2}$ and $0 \leqq z_T < 1$ there is no optimal action y_{T-1} for the government. For $p_{T-1} \leqq \frac{1}{2}$ the payoff to the government

$$J_g(T-1,p_{T-1}) = 2z_{T-1} - 2 + y_{T-1}v_g(T,p_T)$$

with

$$p_T = p_{T-1}/[p_{T-1} + (1 - p_{T-1})y_{T-1}]$$

has a supremum

$$\sup J_g(T-1,p_{T-1}) = 2z_{T-1} - 2 + p_{T-1}/[1 - p_{T-1}], \; p_{T-1} \leqq \tfrac{1}{2},$$

but this supremum can only be reached for $z_T = 1$. For $z_T < 1$ any action $\tilde{y}_{T-1}$ considered can be improved by an action $\hat{y}_{T-1}$ which gives a larger payoff. Figure 1 shows the controllable part $y_{T-1}v_g(T,p_T)$ of the payoff as a function of the action y_{T-1}. For $y_{T-1} = p_{T-1}/[1 - p_{T-1}]$ the function value lies somewhere on the half open interval represented by the dashed line.

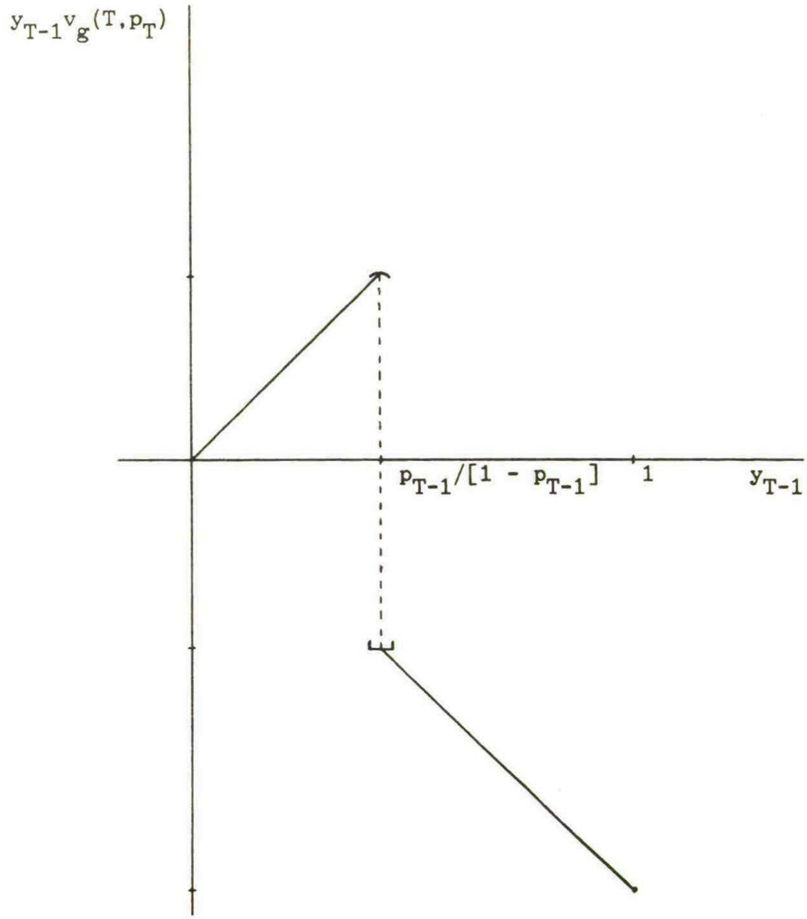

Figure 1

If $p_{T-1} = \frac{1}{2}$ then $p_{T-1}/[1 - p_{T-1}] = 1$ and the negative part of the figure disappears. Table 1 shows which actions $\hat{y}_{T-1}$ give a larger payoff considering all possible actions $\tilde{y}_{T-1}$.

Table 1

$\tilde{y}_{T-1} < p_{T-1}/[1 - p_{T-1}]$	$\tilde{y}_{T-1} < \hat{y}_{T-1} < p_{T-1}/[1 - p_{T-1}]$
$\tilde{y}_{T-1} = p_{T-1}/[1 - p_{T-1}]$	$(2z_T - 1)\tilde{y}_{T-1} < \hat{y}_{T-1} < p_{T-1}/[1 - p_{T-1}]$
$\tilde{y}_{T-1} > p_{T-1}/[1 - p_{T-1}]$	$\hat{y}_{T-1} < \tilde{y}_{T-1}$

For $z_T = 1$, however, the optimal action is

$$y_{T-1} = p_{T-1}/[1 - p_{T-1}],\ p_{T-1} \leqq \tfrac{1}{2},\ z_T = 1.$$

This implies that, in contrast with what Backus and Driffill claim on pages 533 and 534, the only equilibrium action of the public at period T for $p_T = \frac{1}{2}$ is $z_T = 1$. The same applies for all the other periods which yields the equilibrium strategy for the public

$$z_t = \begin{cases} 1,\ p_t \geqq (\tfrac{1}{2})^{T-t+1}, \\ \\ 0,\ p_t < (\tfrac{1}{2})^{T-t+1}. \end{cases}$$

The equilibrium strategy for the "wet" government remains the same as in Backus and Driffill. The expression for the value function on page 535, however, should be corrected and not only due to the changes in the publics strategy. The correct expression is

$$v_g(t,p_t) = \begin{cases} (2^{T-t+1} - (T-t+2))p_t/[1-p_t] - (T-t+1), & 0 \leqq p_t < (\frac{1}{2})^{T-t+1}, \\ (2^{i+1} - (i+2))p_t/[1-p_t] - (i-1) & , (\frac{1}{2})^{i+1} \leqq p_t < (\frac{1}{2})^i, \\ & \quad i = 1,2,\ldots,T-t, \\ 1 & , p_t \geqq \frac{1}{2}, \end{cases}$$

$t = 1,2,\ldots,T-1.$

The consequences of these changes for the example in Section III of Backus and Driffill are that if the government does not inflate the public always expects zero inflation. The reputation of the government in the periods after period one grows just enough to induce the public to choose zero expected inflation with probability 1. This means that, in contrast with what Backus and Driffill claim on page 535, the probability of getting a recession ($x^e = 1$, $x = 0$) is zero. The expected payoff to the government $v_g(1,p_1)$ is equal to $(26p_1/[1-p_1] - 3)$ which is still better than the payoff -4 resulting from not playing the reputational strategy. If the government, however, chooses zero inflation with probability 1 and if the initial reputation is bad ($p_1 < 1/32$ in the example), the reputation remains bad according to Bayes' rule and the public expects inflation with probability 1 which leads to a heavy recession.

II. Conclusion

Backus and Driffill use the sequential equilibrium concept to solve the macroeconomic policy game of inflation and expected inflation formulated by Barro and Gordon. If there is a possibility that the private sector believes that the government is "hard-nosed", a "wet" government can build up a reputation of being "hard-nosed" in order to create some surprise inflation with a raise in output. Backus and Driffill also conclude in their article that the sequential equilibrium induces a positive probability of recessions. This comment shows, however, that due to a technical error in the derivation of their sequential equilibrium this conclusion does not hold. The only sequential equilibrium for this macroeconomic policy game attaches zero probability to the case of recessions. Recessions only occur if the government is "hard-nosed" but has a very bad reputation of being so.

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